INITIAL SITE INSPECTION OF MOTORCYCLE COLLISIONS WITH ROADSIDE OBJECTS IN NEW JERSEY

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ABSTRACT

This paper details the methods used to investigate motorcycle collisions with roadside objects and the initial findings of the study. One factor associated with the frequency and severity of motorcycle collisions with roadside objects may be the design and maintenance of the road. Two methods of analysis were used to investigate the influence of the road geometry and design of roadside environment on motorcycle collisions. Satellite imagery was used to develop an overview of different collision sites. Individual site visits for 34 motorcycle-roadside object crashes were conducted to record details about each site, including types of guardrails and distance of the object struck from the road.

INTRODUCTION

Motorcyclists are overrepresented in guardrail collisions. Motorcycles comprise only 2% of vehicles on the roads, but account for 42% of all guardrail collisions (Gabler, 2007). Motorcyclists are more vulnerable on the road than other vehicle passengers due to the instability of their vehicle as well as greater exposure to the outside environment. There are various causes of motorcycle crashes, including the design and maintenance of the road. Roadside environments were further investigated to determine characteristics that may lead to a higher risk for motorcyclists running off the road. Potential design factors include road curvature, superelevation, barrier type, and barrier offset distance from the travel lane. Road surface factors of interest include the presence of rumble strips, potholes, cracking, painted areas, and gaps between the road surface and bridge decks.

OBJECTIVE

The objective of this paper is to describe the methods used to develop a database with detailed information about roadside object motorcycle collision sites and to report the findings of the initial analysis of the cases investigated to date.

METHODS

The cases used in this study were extracted from the New Jersey Crash Records Database (NJCRASH) for calendar years 2005-2008. NJCRASH is a complete collection of police accident reports which are available in electronic form. Of particular value to this project, most crashes have been geocoded with the latitude / longitude coordinates of the crash site. The geocoded locations of motorcycle-roadside object collisions were investigated using two methods: a satellite image analysis and an individual site inspection. For this pilot study, a subset of these cases was investigated to determine the feasibility of our approach. Motorcycle collisions with guardrails, concrete barriers, poles, and trees were investigated.

Satellite Imagery Analysis

The imagery analysis gave a first look at the different guardrail collision sites. Using the latitude and longitude data recorded in the NJCRASH database, sites were located on satellite images using Google Earth Pro. A screenshot was taken of each collision site and incorporated with data tables that displayed information about the accident based on the coded NJCRASH Data. The tables incorporated data about the time and date of the crash, location, information on the rider and motorcycle, and sequence of events to give an overall description of each accident.

The radius of curvature was also investigated through the satellite imagery analysis. Collisions that occur on any size curve are listed simply as ‘curve’ in the NJCRASH database. NJCRASH does not describe the radius of the curve. However, it is important to know the radius of a curve: curves with smaller radii may be more dangerous for riders (FEMA, 2000). Thus, comparing the radii of curves on which collisions occurred may help in determining the geographic locations where accidents are occurring.

Google Earth Pro was used to measure the radii of curves where collisions occurred. The circle tool used to draw a circle on the image. The tool measures the radius of the circle, which can be adjusted by dragging the endpoint of the radius on the map. The center of the circle can also be adjusted by dragging the center to a new location. Using these two operations, the circle was fit as best as possible to the curve (Figure 1). The median of the road was used as guidance in determining the curvature of the circle, and, when possible, the circle was fit to the median. On roads where there was no median, the lines on the road were used as reference if they were visible in the satellite imagery.

Figure 1. Example radius of curvature measurement from Google Earth Pro. This collision occurred in Mercer County on Route 640. The radius of curvature is 200 feet.

Once the circle was fit to the curve, the radius of the circle was recorded to the nearest foot. The Google Earth Pro tool records the radius to the nearest hundredth of a foot; however, the rounding was made in order to compensate for human error in fitting the circle to the curve.

Site Survey Data Collection

Though satellite imagery provided an introduction to the area where a crash occurred, the imagery is not of a high enough resolution to determine smaller characteristics of the road, such as variations in the surface and the type of guardrail surrounding the road. Motorcycles are more vulnerable to these variations as they are significantly less stable than other motor vehicles. Data currently available through NJCRASH does not include detailed information about the roadside objects, such as the distance of a struck object from the road or the condition of the object.

Site visits were conducted to methodically document the characteristics of the roadway, roadside, and barrier at each crash site. A data collection form was used to ensure the same information was gathered at every site. It allowed for investigators to select specific characteristics from a list of options, with the option of adding characteristics that were not included. This format allows for simpler analysis of data as opposed to a sheet without any options because there are a finite amount of responses to each question. Photographs were taken in order to compare the road conditions and surrounding environments around each crash site. The data collection sheet contains a check list of photographs to be taken to ensure that common features can be compared. The data elements collected in each site inspection are presented in Table 1.

Table 1.
Information gathered at sites by data element type

Data Element	Characteristics
Barrier Characteristics	Concrete Barrier
	Type
	Height
	Damage
	Guardrail
	Rail type
	Post type
	Blockout type
	Terminal type (if applicable)
	Distance between posts
	Damage to rail/posts
	Additional features

Table 1 (continued).

Data Element	Characteristics
Roadside Characteristics	Shoulder presence
	Rumble Strip
	Surface
	Division
	Potholes
	Patches
	Notable Cracks
	Contaminants
Dimensions	Object to pavement edge
	Distance
	Slope
	Pavement edge to lane end
	Distance
	Slope
	Ground to bottom of rail (if applicable)

The main focus of the collection process was on motorcycle-guardrail collisions. Several different characteristics about the guardrail were observed through site visits. First, the type of rail was recorded since this is the main component of the guardrail. Moreover, the height of the rail from the ground was measured. In the event of a collision a motorcyclist can fall from his/her motorcycle and slide under the guardrail, potentially colliding with the post. Second, the type of post was recorded. Posts prove to be one of the greatest hazards to motorcyclists as they have narrow faces and edges which concentrate the force. Lastly, it was noted if any additional safety measures, such as an additional W-beam or metal guard, were used on the guardrail at the collision site. Characteristics of other roadside objects were incorporated such as type of concrete barrier, pole type, and any distinguishing features.

Characteristics about the roadway were also observed to see if there were common aspects of the road that could potentially be a cause of an accident. It was noted if there were any potholes, patches, or cracks in the road, as a motorcycle can lose stability from riding over one of these defects. Any abrupt changes in the elevation were noted as these are also hazardous to motorcyclists. However, these characteristics may have changed from the time of the crash. Several design aspects of the road were also examined. First, it was noted if there was a rumble strip in the shoulder as the high surface variation may cause a rider to lose control. It was also noted if there was paint on the road, as this has a different coefficient of friction from the road surface and this change, though not significant to other motor vehicles, may cause a rider to lose control.

Measurements of the shoulder width, slope, and distance between the object and end of the pavement were also taken at each site. A diagram was included in the survey sheet to clarify the required measurements (Figure 2). The distance of the object from the road may have an effect on the severity of a collision; if the object is further away from the flow of traffic, the motorcyclist will have more time to slow down before colliding with it.

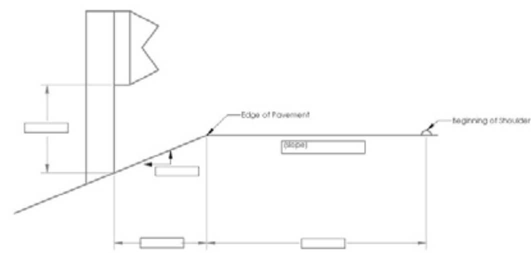

Figure 2. Guardrail and Road Environment Measurements. This figure was included in the site survey sheets to gather data about the distance of the object from the road and the slope of the road.

Police reports for each site visited were obtained from the New Jersey Department of Transportation before most site visits. The police reports contained more information about the occurrences of the accident, sometimes including a diagram. This additional information facilitated finding the site and exact location of the collision, as many sites had multiple poles, trees, or lengths of guardrails.

RESULTS

To date, a database of 34 collisions which have occurred at 31 crash sites has been developed. Four crashes occurred at the same location. Table 2 presents the composition of the resulting dataset. This includes 17 guardrail collision sites, 11 pole collision sites, 4 tree collision sites, and 1 concrete barrier collision site. The majority of the collisions (29) occurred in either 2007 or 2008.

Table 2.
Composition of Data Set of Motorcycle-Roadside Object Collisions (NJCRASH 2005-2008)

Variable	Number of Cases
All	34
Year of Crash	
2005	1
2006	4
2007	25
2008	4
Object Struck	
Guardrail	17
Concrete Barrier	1
Poles	12
Trees	4
Injury Severity (KABCO)	
Fatality	5
Incapacitating Injury	7
Moderate Injury	15
Complaint of Pain	7
Property Damage Only	0

Example Case

On Route 579 in Bethlehem Township in Hunterdon County, a crash location was investigated where there were 4 motorcycle-guardrail collisions in 2007. The posted speed limit on the road is 35 mph, with a reduction to 10 mph around the curve. The road took a sharp turn left, and disappeared from vision due to the downgrade of the road (Figure 3). There were two driveways ending at the curve.

Figure 3. Route 579, Bethlehem Township, Hunterdon County. Four motorcycle-guardrail collisions took place at this site in 2007.

There were at least 5 areas of damage along the W-beam guardrail, suggesting other vehicle crashes had occurred on the same curve (Figure 4). Some of the steel strong posts were also bent and damaged.

Figure 4. Damage to guardrail. There is notable damage to the rail and the posts in multiple areas.

The distance of the guardrail from the edge of the lane gradually narrows as the road curves left. The guardrail-road offset distance was measured in three places to be 7.4, 5.0, and 4.0 feet from the edge of the lane. Along the curve, the guardrail was located only 0.75 feet from the edge of the pavement. The guardrail is in place to protect vehicles from the wooded slope behind it. The road slopes 11° in the direction of the road. The road angled 23° toward the center of the curve.

During the site visit, a street cleaner was seen at the site, implying that the site is well kept. There was little debris noticed on the side of the road as well. There were no potholes, patches, or large cracks in the asphalt surface of the road. However, the road was rough and uneven (Figure 5), which may be more hazardous for motorcycles than other vehicles.

Figure 5. Road Surface. The surface of the road was noted to be rough and uneven.

The geometry of the site was analyzed using Google Earth Pro. The radius of curvature of the site was measured to be 49 feet (Figure 6). This is a very narrow curve as none of the other sites investigated using the satellite imagery were found to have a radius under 100 feet.

Figure 6. Radius measurement of example site. The radius of the curve was measure to be 49 feet.

Site Survey Data Collection

In our dataset, seventeen motorcycle-guardrail collision sites were investigated. The guardrails all had W-beam rails with steel strong posts (10), steel weak posts (2), or wood strong posts (5). The blockouts used in the strong post guardrail also varied between steel (9), wood (4), recycled material (1), and none (1). This composition is consistent with national guardrail inventories which are primarily strong post w-beam systems.

The distances of the objects from the edge of the lane varied greatly amongst the sites (Figure 7). There were sites where the guardrail was on the edge of the pavement on a street with no shoulder, and others where the guardrail was offset from the edge of the pavement on a road with a significant shoulder.

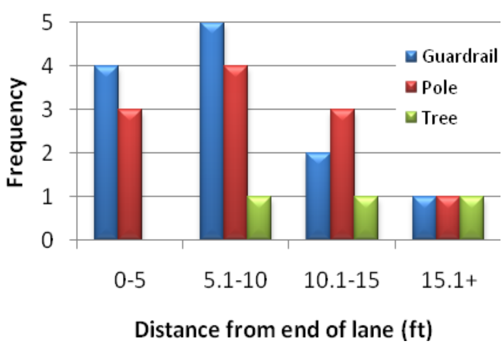

Figure 7. Distance of object from lane edge by object struck.

Of the 31 crash sites investigated, 17 occurred on curves. After visiting the sites it became evident that some of the curves created an obstruction of view. The road surface at the majority of the sites was free of debris and blemishes. There were no evident potholes at any sites, and only 5 sites had notable cracks in the surface.

Satellite Imagery Analysis

A separate analysis for 139 guardrail collision sites in New Jersey from 2005-2007 was conducted. The main component of each site investigated through the use of Google Earth was the radius of curvature at each site. Fifty-eight (41.7%) of the collisions investigated occurred on curves, 41 of which (33.6%) occurred on a curve with a radius of curvature of less than 1000 feet.

The distribution of the crashes across New Jersey was also found after each crash was analyzed (Figure 8). Most motorcycle-guardrail collisions were in northern New Jersey.

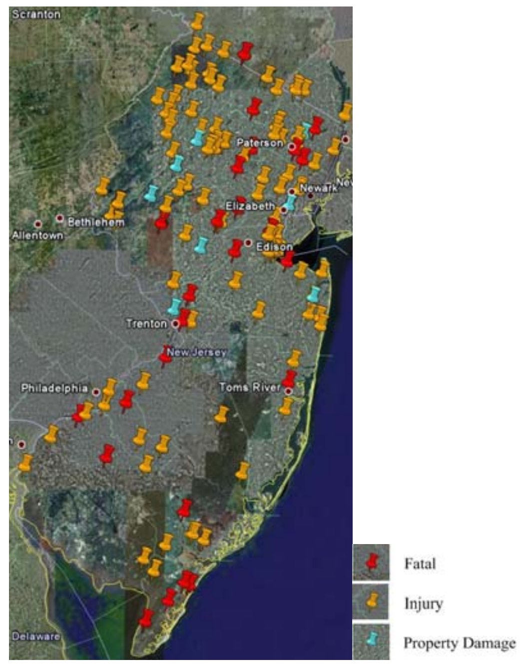

Figure 8. Distribution of motorcycle-guardrail collisions in New Jersey (2005-2007).

DISCUSSION

Two methods of evaluating motorcycle collisions with roadside objects were used to develop an enhanced database about the roads on which these crashes are occurring. Using satellite imagery from Google Earth, the radius of curvature at collision sites was obtained. It was seen that approximately 1/3 of crashes occurred on roads with a radius of curvature of less than 1000 feet. However, these data are limited by the precision of the user to fit a curve to the road.

Motorcycle collision sites were also analyzed through site surveys. Thirty-one sites have been visited to date. One challenge was the occasional unavailability of latitude and longitude data from the NJCRASH database. Most of the recent crashes (2007-2008) were geocoded with these coordinates; however, there were some crashes that were neither geocoded nor included an exact location. In some cases, positioning coordinates appeared to be inaccurate. In several cases, the investigators' judgment was used to deduce the location of the crash.

A second challenge has been to obtain safe access to the sites for physical measurements. Many of the collisions occurred on main roads with higher speed limits. These roads sometimes have no place for investigators to safely stop for the inspection. For sites that were too dangerous to investigate thoroughly, a drive-by investigation was completed. This allowed for general information to be gathered about each site, though no measurements could be taken.

A third challenge was the need to promptly visit a crash site after the incident. We investigated several sites years after the incident with the hope that characteristics, e.g. barrier type or road curvature, would be unlikely to have changed. Some characteristics however, e.g. defects in the roadway surface or barrier damage, may have been repaired prior to our site inspections. To account for this possibility, our protocol required that the investigator note any indications of repair, e.g. new barriers or poles.

CONCLUSION

This paper has presented the design of a novel database containing detailed road design and maintenance information about motorcycle collision sites with roadside objects. This database extends the traditional databases of police-reported crash reports with engineering data such as guardrail type and distance of object struck from the road. Thus far, 31 sites have been investigated, supplemented with an analysis of satellite imagery. This database will provide researchers with more information to determine what environmental aspects are characteristic of motorcycle crashes. Identifying these characteristics and taking action to modify them, making them more motorcycle-friendly, will lead to a reduction in the severity of motorcycle crashes with roadside objects.

ACKNOWLEDGEMENTS

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